CLARIFICATIONS OF THE PLM EGSE INTERNAL INTERFACE CONTROL DOCUMENT FOR THE AVHRR AND HIRS INSTRUMENTS

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Prepared By

William Mocarsky Date:
Code 566

James Mentall Date:
Code 480

Approved By

Douglas Fineberg Date:
AVHRR and HIRS Technical Officer
NAS5-30384

Steve Pszcolka Date:
METOP GSE Manager

Mark Brumfield Date:
POES Instrument Systems Manager

Daniel G. Flanagan Date:
NOAA Liaison Office POES Project
Systems Acquisition Office, NOAA

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CLARIFICATIONS OF THE PLM EGSE INTERNAL INTERFACE CONTROL DOCUMENT FOR THE AVHRR AND HIRS INSTRUMENTS

1. INTRODUCTION

This document describes the interfaces between the METOP Electrical Ground Support Equipment (EGSE) and the ITT HIRS and AVHRR Transportable Bench Check Unit (TBCU). These systems will be used as the observatory ground data processing equipment during HIRS and AVHRR instrument integration onto the METOP Payload Module (PLM), observatory level testing, pre-launch and launch support.

1.1 Purpose and Scope

This document is a consolidation of information found in other METOP documents pertinent to this interface with clarifications and additions made where necessary. The document defines the METOP interfaces that ITT must satisfy.

1.2 Acronyms

A list of acronyms is included in Appendix E.

1.3 Reference Documents

Document Number / Date	Title
MO-IC-MMT-AH-0001, Issue 2, Rev: 0 (Redlined) As Signed by NOAA, NASA, ESA, and EUMETSAT, July 10, 1998	Advanced Very High Resolution Radiometer /3 Instrument Interface Control Document (AVHRR/3 ICD)
MO-IC-MMT-HI-001, Issue 2, Rev: 0 (Redlined) As Signed by NOAA, NASA, ESA, and EUMETSAT, July 10, 1998	High Resolution Infra-red Radiation Sounder/4 Instrument Interface Control Document (HIRS/4 ICD)
MO-ID-DOR-PM-0018, Issue 2, Rev: Dated June 25, 1998	PLM EGSE Internal Interface Control Document
MO-RS DOR-PM-0004, Issue 1, Rev. A dated May 13, 1997	NOAA Instrument Interface Unit Requirements Specification

1.4 General Data Flow

The general flow of data between the METOP EGSE and the ITT TBCU is depicted in Figure 1.4-1. Essentially:

a. The METOP Special Checkout Equipment (SCOE) extracts instrument measurement data. The data are forwarded to the NOAA Data Acquisition and Processing Block (N-DAPB) that relays the measurement data packets to the ITT TBCU associated with the respective instrument.
b. The packets containing all NOAA provided instrument housekeeping data are extracted by the METOP Data Front End Equipment (DFE) and forwarded to the N-DAPB by the METOP Core EGSE. The N-DAPB separates each instrument's contribution to the housekeeping data stream into individual packets unique to an instrument and relays those data packets to the ITT TBCU associated with the instrument.

c. The Core EGSE relays unformatted command echo messages to the N-DAPB for each NOAA instrument command issued by the METOP EGSE. The N-DAPB converts these unformatted command echo messages to command echo message packets that contain command mnemonics. The N-DAPB then forwards these formatted command echo messages to the ITT TBCU associated with the appropriate instrument.

d. The N-DAPB forwards error messages and informational messages to the appropriate ITT TBCU that it has received from the Core EGSE or that the N-DAPB has generated itself.

e. The N-DAPB receives error and informational messages from the ITT TBCUs. The N-DAPB may forward these messages to the METOP Core EGSE

1.5 Operational Philosophy

The general operating philosophy of the METOP-ITT TBCU combination is:

a. The METOP EGSE has the ability to determine the health, safety and response to commands by the AVHRR and HIRS instruments directly from the housekeeping data stream.

b. Requests from the METOP integration and test personnel to evaluate the HIRS and AVHRR measurement data (Dig A data) will be made verbally. The results of these evaluations will be reported to the METOP personnel verbally.

c. ITT is providing a TBCU for each of its instruments, HIRS and AVHRR.

The justification for this approach is that the measurement data for the AVHRR and HIRS instrument does not contain any useful information during ambient conditions. It is only when the detectors are cooled that the measurement data is meaningful and should be evaluated. During those tests, instrument personnel will be available to perform the evaluation of the data.

1.5.1 Data Analysis Upgrades

Based upon previous MetOp PLM level testing the following enhancements shall be implemented:

A. Software Upgrades

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A1. Post processing software shall be developed for the PC-based DAN to analyze collected data during EMI (radiated and conducted) testing that can detect both periodic and sporadic interference through analysis of the entire earth-scene data.

A2. Image processing software shall be created to generate products and statistics based on column mean removal of the image data (including Volt Cal analysis and E-cal analysis routines.)

A3. Manual menu-driven “point and click” software processing shall be created to begin image processing immediately upon receipt of file from MIB and to handle archiving.

A4. MIB limit files shall be upgraded and known MIB software bugs shall be addressed. Add functionality to monitor the filter wheel period monitor (HIRS and scanner jitter (AVHRR). Troubleshoot problems as uncovered (HIRS parity error problems and AVHRR channel 5 glitch).

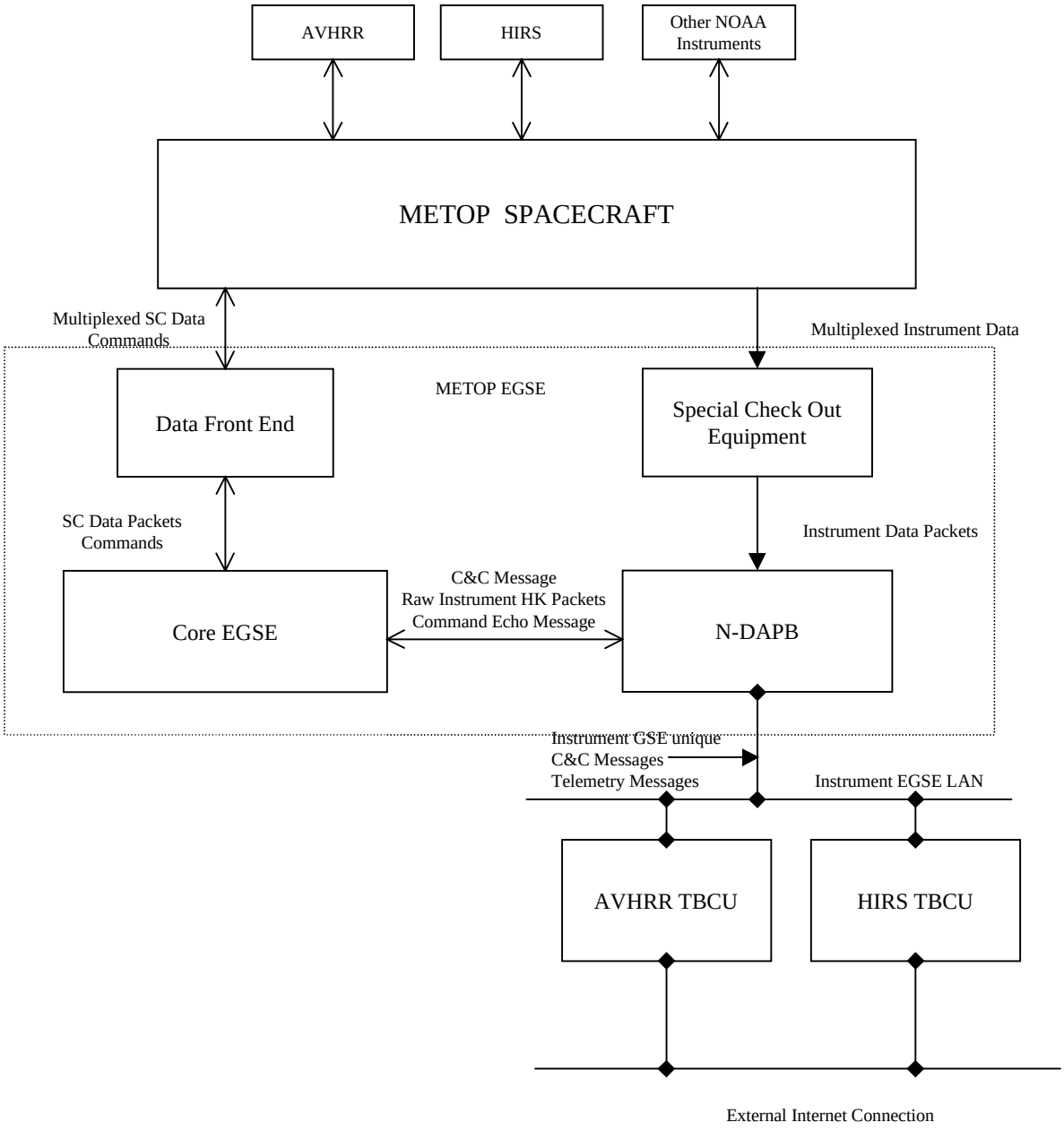
A5. Newly developed software shall be tested both at ITT (on new EGSE) and in Europe. Methods shall be developed to test the MIB using MetOp data nd to simulate packet rate variations.

A6. Software shall be developed to trend all parameters in the ASCII output files from the DAN “quick look” software (A1. above).

B. Hardware Upgrades

ITT shall develop the capability to archive (at the Fort Wayne facility) 24 hours of AVHRR and HIRS data in the format that is currently presented to the MIB during S/C testing. Data shall be transferred to the ITT facility via a line provided via the above connection.

Figure 1.4-1: General flow of data between the METOP EGSE and the ITT TBCU



2. INSTRUMENT EGSE NETWORKING AND COMMUNICATIONS

The following sections describe the physical medium for exchanging messages: the underlying protocol for message exchange and an overview of the protocol layered on top of that protocol.

2.1 Physical Attributes

The physical layer is 10Base-2 (thin wire) coax cabling with a 50Ω termination. This network is a private network shared by the N-DAPB and all NOAA instrument data processing equipment.

2.2 Underlying Protocol

The protocol used to exchange all messages between the N-DAPB and ITT TBCUs is TCP/IP using Ethernet conforming to IEEE 802.3.

2.3 Application Protocol Specification

The following sections define the overlaying protocol, initialization and termination procedures to be followed.

2.3.1 CCSDS Packets

All messages issued between the N-DAPB and TBCUs are structured as CCSDS source packets. In conformance with the CCSDS standards, the left-most bit of a multi-bit field shown in drawings is numbered **Bit 0** and is the first bit transmitted. **Bit 0** of a multi-bit field is the most significant bit. Similarly, the first byte of a data field is numbered as **Byte 0.** The basic structure of the source packets exchanged between the N-DAPB and TBCUs is shown in Figure 2.3-1. NOTE: There are three different times used by the CCSDS Packets: Spacecraft time, UTC, and OBT. Spacecraft time is defined as UTC with Time 0 defined as January 1, 2000. The OBT Time is defined by the NIU.

Figure 2.3-1 Source Packet Structure

Version #	Bits 0-2	Measurement TM Housekeeping TM C&C Message	= 000_2 = 011_2 = 011_2
Type	Bit 3	Telemetry (TM) Command and Control (C&C) Message	= 0 = 1
Header Flag	Bit 4	Flag indicating presence or absence of the secondary header	0=> Secondary header absent 1=>Secondary header present
APID	Bits 5-15	APID is a numeric identify when used in conjunction with the Version # And Type, it indicates the purpose and content of the message	
Segment Flags	Bits 16-17	Indicates that the complete message is contained in 1 Packet	11_2
Source Sequence Count	Bits 18-31	Sequential counter (modulo 16384) incremented each time a message of the same Version #, Type and APID is issued. Note that its value may not be 0 for the first message received.	
Packet Length	Bits 32-47	number of bytes (octets) in the data field – 1.	
Secondary Header	Bits 48-111	If present, the secondary header indicates the spacecraft time (UTC) of the measured event. The SC time EPOCH is Jan 01, 2000. The format is: Bytes 0-1 Number of days Bytes 2-5 Millisecond of day Bytes 5-7 Microsecond of day	
Ancillary Info OBT	Bits m-(n-1) m=48 or 112	This field, if present, is the OBT time of the event. The presence or absence of this field is by convention and is Determined by the APID, Version # and Type fields. The format of the OBT time is: Byte 0 Zero Bytes 1-3 Coarse time in seconds. MSB first Bytes 4-5 Fine time in 2^{-16} seconds. Note that the 8 least significant bits are 0.	
User data	Bits n-(k-1)	Packet data. Must be multiple of 2 bytes. The interpretation of this data is dependent upon the Version #, Type and APID fields.	
Packet Error Code	Bits k-(k+15)	The presence or absence of this field is determined by Convention based upon the Version #, Type and APID. It is computed by performing an exclusive-or over all other byte (octet) pairs in the packet	

2.3.2 Socket Usage

Two stream sockets are used for each of the TBCUs. These sockets are denoted as the Send Unsolicited Message Socket (SUMS) and the Read N-DAPB Initiated Messages Socket (RNIMS). The SUMS is used by the TBCU to send unsolicited Command and Control messages (C&C) to the N-DAPB and receive all ACK/NACK messages associated with the unsolicited C&C messages initiated by the TBCU. The RNIMS is used by the TBCU to receive all unsolicited C&C messages from the N-DAPB, telemetry messages, and command echo messages and return the ACK/NACK messages associated with each C&C message received on the RNIMS. Connections must be established for both sockets because the N-DAPB will attempt to make connections on both and may consider it an error if it cannot establish them.

2.3.3 NOAA Data and Processing Block (N-DAPB) Client Process

The N-DAPB is the client for all communication between the N-DAPB and the TBCUs.

2.3.3.1 Session Initialization

The N-DAPB executes the equivalent to the following logic to establish a communication link with each TBCU:

- Connect to network by obtaining a TCP/IP socket (socket call)
- Send connect request to the N-DAPB on the predetermined port to selected TBCU (connect call)
- N-DAPB is ready to exchange application messages with the TBCU over the connected socket.

2.3.3.2 Error Recovery

In the event of an abnormal loss of communication, the N-DAPB shall attempt to re-establish the communication path using the Session Initialization logic for the failed communication path as described above. If the TBCU was in the “ON-LINE” mode, the N-DAPB shall reissue the “Transfer Online” message. No attempt is made to send any data that may have been lost during the period the communication path was not functioning.

2.3.4 Transportable Bench Check Unit (TBCU) Server Process

Each TBCU is a server for the N-DAPB.

2.3.4.1 TBCU Port Assignments

Two port numbers will be assigned to each of the TBCUs as shown in Table 2.3-2. [1]

[1] Port numbers are assigned to differentiate processes that must use the TCP/IP connection to the TBCU. Per a request from METOP, the TBCU shall be capable of changing the port number assignments once METOP has finalized their GSE design and port number assignments.

Table 2.3-2 Port Identifications

Port Number	TBCU	Communication Path
TBD1	AVHRR	SUMS – AVHRR TBCU issued C&C messages
TBD2	AVHRR	RNIMS—N-DAPB initiated messages for AVHRR
TBD3	HIRS	SUMS-HIRS TBCU issued C&C message
TBD4	HIRS	RNIMS-N-DAPB initiated messages for HIRS

2.3.4.2 Session Initialization

Each TBCU executes the equivalent of the following logic to establish a communication link with the N-DAPB for the each of the SUMS and RNIMS data streams.

- Connect to network by obtaining a TCP/IP socket (socket call)
- Associate created socket with predetermined port unique to TBCU for communication path. (bind call)
- Prepare for network connection.(listen and accept call)
- If a successful connection, the N-DAPB is ready to exchange application messages with the TBCU over the specified socket for the specified service.

Connections to each port may be made in any order. For example, the N-DAPB may request connection to the SUMS socket prior to connecting to the RNIMS socket.

2.3.4.3 Error Recovery

In the event of an abnormal loss of communication with the N-DAPB, the TBCU will attempt to re-establish communication with the N-DAPB for the communication path that failed. It will do that by following the Session Initialization procedure for the failed path as specified above. The TBCU should accept any "Transfer On-Line" messages issued over the RNIMS even if the TBCU is already on line.

2.3.4.4 Session Termination

Either the N-DAPB or the TBCU may initiate session termination.

Upon receipt of a "Transfer Offline" message on the RNIMS from the N-DAPB, the TBCU will issue an ACK message on the RNIMS and then closes both sockets associated with the N-DAPB. At this point, TBCU operator intervention may be required to restart the session.

TBCU initiated session termination is not expected to be the normal termination process. In this scenario, the TBCU issues a "Transfer Offline" message to the N-DAPB over the SUMS. Upon receiving an ACK from the N-DAPB over the SUMS, the TBCU closes both sockets. The TBCU operator may be required to restart the session.

2.3.5 Message Protocol

The following protocol shall be followed between the N-DAPB and each TBCU:

a. The receiver of a C&C message, other than an ACK/NACK C&C message, must respond with an ACK or NACK to the message initiator.
b. The sender of a C&C message shall not issue another C&C message until it receives an ACK or NACK for all previous C&C messages. The sender may issue telemetry messages prior to receiving the ACK or NACK.
c. Telemetry messages and ACK/NACK C&C messages shall not to be acknowledged by the receiver of the message.
d. The receiver of an invalid message shall respond with a NACK. The receiver shall not terminate a session.

3. General Message Formats

All messages transferred between the N-DAPB and TBCUs shall be formatted as CCSDS packets.

3.1 Command and Control Message Format

Command and Control messages shall be compatible with the Backus-Naur syntax as defined in the PLM EGSE Internal ICD. It is noted that the data field of the C&C packets is ASCII, case insensitive, variable length and does not include either the secondary header, ancillary info OBT field, or the Packet Error Code. The detailed format of each C&C message exchanged between the N-DAPB and TBCUs is documented in Appendix B.

3.2 Telemetry Message Format

The telemetry messages include AVHRR measurement data (Dig A), AVHRR housekeeping data (Dig B and analog), HIRS measurement data (Dig A), and HIRS housekeeping data (Dig B and analog) messages. Data unique to each instrument are transmitted only to the TBCU associated with that instrument. Measurement data packets (dig A data) contain both the spacecraft UTC time field (secondary header) and the ancillary OBT time fields as well as the packet error code. Housekeeping data packets do not contain any of these fields, but do contain the ICU onboard time within the “User data” field. This time field contains the 24-bit OBT coarse time and the 8 most significant bits of the OBT fine time. The TBCU shall not issue an ACK/NACK response to these messages. The detailed format of each telemetry message is documented in Appendix A.

4. MESSAGES ON THE RNIMS

The following section address the messages exchanged on the RNIMS communication path.

4.1 N-DAPB Initiated Messages

The N-DAPB initiates the messages described in the following subsections.

4.1.1 Measurement Telemetry Message

The N-DAPB transmits to each TBCU the instrument measurement data packets for the instrument associated with the TBCU. The data packets are the raw data packets with the user data format and order in the same format as sampled by the spacecraft. The measurement data may lag the housekeeping data by up to 30 seconds. No ACK/NACK is to be issued in response to this message. The N-DAPB will only send packets with a correct Packet Error Control code. The details of the HIRS and AVHRR measurement packets are defined in Appendix A.

4.1.2 Housekeeping Telemetry Message

The N-DAPB extracts housekeeping data from the spacecraft data stream, formats the data into packets containing data unique to each instrument and forwards that data to the respective TBCU. The housekeeping data may lead the measurement data by 30 seconds. No ACK/NACK is to be issued in response to this message. The details of the HIRS and AVHRR housekeeping packets are defined in Appendix A.

4.1.3 Command Echo C&C Message

The N-DAPB converts the binary formatted telecommand packet information for each instrument to the ASCII mnemonic of the command, places it into a C&C packet and forwards it to the TBCU associated with the instrument receiving the command. The command echo message may be delayed by 2 seconds relative to the transmission of the command to the spacecraft and may lead the associated housekeeping and measurement data by 30 seconds. The details of the command echo messages are defined in Appendix B.

4.1.4 TRANSFER ONLINE Message

The N-DAPB will issue the TRANSFER ONLINE message to the TBCU. Upon successful receipt and ACK of this message, the TBCU will read and process all telemetry messages sent by the N-DAPB on the RNIMS communication path. The format of this message is specified in Appendix B.

4.1.5 TRANSFER OFFLINE Message

The N-DAPB will issue the TRANSFER OFFLINE message to the TBCU to indicate that the TBCU is to disconnect from all open sockets. The TBCU shall respond with an ACK message prior to disconnecting. The format of the message is defined in Appendix B.

4.1.6 MESSAGE Message

The N-DAPB may issue textual informational messages to the TBCU. The format of this message is defined in Appendix B.

4.1.7 Unexpected N-DAPB Messages

The TBCU is not to terminate the session upon receipt of an unexpected message. If the N-DAPB issues an unexpected message on the RNIMS, the TBCU will notify its operator of the event and respond to the N-DAPB with a NACK.

4.2 TBCU Initiated Messages

The TBCU will only transmit ACK or NACK messages on the RNIMS.

4.2.1 ACK Message

The TBCU will issue an ACK message for each C&C message successfully processed by the TBCU that was issued by the N-DAPB over the RNIMS. The format of the message is specified in Appendix B.

4.2.2 NACK Message

The TBCU will issue a NACK message whenever it receives a C&C message that is improperly formatted or a C&C message that it does not respond to. The format of the message is specified in Appendix B.

5. MESSAGES ON THE SUMS

The following subsections identify all the messages exchanged on the SUMS communication path.

5.1 TBCU Initiated Messages

The TBCU may issue the following unsolicited messages to the N-DAPB using the SUMS communication path.

5.1.1 TRANSFER OFFLINE Message

The TBCU may issue the TRANSFER OFFLINE message to the N-DABP to indicate that the N-DAPB is to disconnect from all open sockets for the particular TBCU. The N-DAPB shall respond with an ACK message prior to disconnecting. Upon receipt of an ACK, the TBCU shall close its sockets with the N-DAPB. The format of the message is defined in Appendix B.

5.1.2 MESSAGE Message

The TBCU may issue textual informational messages - i.e., a message for the operator (not code) - to the N-DAPB. The format of this message is defined in Appendix B.

5.1.3 ERROR Message

The TBCU may issue ERROR C&C messages to the N-DAPB. The error messages are used to inform the N-DAPB of some abnormal condition that was detected by the TBCU. The exact content of these messages needs to be negotiated with the METOP PLM EGSE developer after the TBCU developer identifies the error conditions it desires to notify the N-DAPB of. The general format of this message is specified in the Appendix B.

5.2 N-DAPB Initiated Messages

The N-DAPB will send the following messages to the TBCU over the SUMS communication path.

5.2.1 ACK Message

The N-DAPB will issue an ACK message for each C&C message successfully processed by the N-DAPB that was issued by the TBCU over the RNIMS. The format of the message is specified in Appendix B.

5.2.2 NACK Message

The N-DAPB will issue an NACK message for each C&C message not successfully processed by the N-DAPB that was issued by the TBCU over the RNIMS. The format of the message is specified in Appendix B.

6. TBCU INTERNET ACCESS

An external Internet connection for the purpose of software maintenance, TBCU performance monitoring and file exchange is required by the TBCU**.**

APPENDIX A – TELEMETRY MESSAGES

The content of this appendix is based upon Draft 2.1, dated August 21, 1998 of the PLM EGSE ICD and the NOAA Instruments Interface Unit (NIU) Requirements Specification, Issue 1 Rev. A dated May 13, 1997.

A.1 AVHRR Measurement Data (Dig A)

The AVHRR measurement data contains a complete instrument scan of data. Only data taken during the following periods occur in the data packet:

Detector: Space View
Electronic Ramp Calibration
Detector: Earth View
IR Target Temperature
Patch Temperature
Detector: IR Backscan

The CCSDS packet header information for these packets is:

Version #	=	000_2
Type	=	0
Secondary Header Flag	=	1 => presence of S/C UTC time tag
APID	=	67_{16} => Channel 3A 68_{16} => Channel 3B
Segment Flag	=	11_2
Packet Sequence Count	=	Sequential counter (Modulo 16384). Note That the first packet transmitted to TBCU may not start at zero.
Packet length	=	Number of data bytes in packet data field –1 12959_{10}

The data field within the packet includes:

Bytes	Definition
Bytes 0-7	Spacecraft UTC time code as defined in Section 2.3.1. The time code indicates the UTC of the leading edge of the AVHRR line sync pulse.
Bytes 8-13	Ancillary Info OBT time field as defined in Section 2.3.1 The time code indicates the OBT time of the leading edge of the AVHRR line sync pulse.
Bytes 14-12957	2071 samples of each of the 5 channels of AVHRR DIG A data. The data are sampled at the periods indicated above. The 10 bit detector data are packed back-to-back in the following order: Channel 1 Channel 2 Channel 3A/3B (determined by APID) Channel 4 Channel 5 The 10 bit fields are ordered so that the most significant bit (AVHRR data line #1) is transmitted first. Note that the LAST 2 bits of byte 12957 are indeterminate and are present to fill out the last byte. **(TBC)**
Byte 12958-12959	Packet Error Control as defined in Section 2.3.1

A.2 AVHRR Housekeeping Data

The AVHRR Housekeeping Data Packet Header information is

Version #	=	011_2
Type	=	0
Secondary Header Flag	=	0=> No presence of S/C UTC time tag
APID	=	$7FD_{16}$
Segment Flag	=	11_2
Packet Sequence Count	=	Sequential counter (Modulo 16384). Note that the first packet transmitted to TBCU may not start at zero.
Packet length	=	Number of data bytes in packet data field –1. The value of the field is dependent upon the METOP ICU format selected. Valid lengths are: 63_{10} -Real-time Reduced Format 267_{10} –Real-time Format 3123_{10} –Real-time Test Format

Note that there is no UTC or Ancillary Info OBT time field or Packet Error Code for this packet type. The User Data field of this packet contains:

Byte Offset in User Data Field	Definition
0	ICU "Begin Identifier" = constant FF_{16}
1	ICU "Source" field = 71_{16} for AVHRR
2	Bits 0-3 ICU "Type" field indicating Format 9_{16} - Real-time reduced A_{16} -Real-time 3_{16} - Real time Test Bits 4-7 N/A
3	8 bit counter (mod 256) that is common (global) to all formats.
4 – 5	16 bit integer indicating the number of 16 bit data words contained in the "User Data Field"
6 – 9	ICU time field of the data sample. The ICU time field is defined as follows: 3 bytes OBT coarse time in seconds 1 byte OBT subseconds (least significant bit $=2^{-8}$)
10 – 15	Not Applicable
16	AVHRR Dig B status bits defined as follows Bit 0: Scan Motor/Telemetry Status (1=> ON) Bit 1: Electronics Telemetry Status (1=>ON) Bit 2: Channel 1 Status (1=>ON) Bit 3: Channel 2 Status(1=>ON) Bit 4: Channel 3A Status (1=>ON) Bit 5: Channel 3B Status (1=>ON) Bit 6: Channel 4 Status (1=>ON) Bit 7: Channel 5 Status (1=>ON)
17	AVHRR Dig B status bits defined as follows: Bit 0: Channel 3A/B Select (1=>3A) Bit 1: Voltage Calibration Status(1=>ON) Bit 2: Cooler Heater Status (1=>ON) Bit 3: Scan Motor Mode Status (1=>HIGH POWER) Bit 4: Telemetry Lock Status(1=>LOCKED ON) Bit 5: Earth Shield Status (1=>DEPLOY) Bit 6: Patch Control Status (1=>ON) Bit 7: Spare
18	Patch Temperature
19	Patch Temperature Extended
20	Patch Power
21	Radiometer Temperature
22	Blackbody Temperature 1
23	Blackbody Temperature 2

Byte Offset in User Data Field	Definition
24	Blackbody Temperature 3
25	Blackbody Temperature 4
26	Electronics Current
27	Motor Current
28	Earth Shield Position
29	Electronics Temperature
30	Cooler Housing Temperature
31	Baseplate Temperature
32	Motor Housing Temperature
33	A/D Converter Temperature
34	Detector #4 Bias Voltage
35	Detector #5 Bias Voltage
36	Blackbody Temperature IR Channel 4
37	Blackbody Temperature IR Channel 5
38	Reference Voltage
39 - 61	Spare
62 - 63	ICU "End Identifier" = $FFFF_{16}$
64 - end	If present as indicated by the packet length field, contains information pertinent to the ICU such as NON-NOMINAL data. This data shall be considered as spare relative to the TBCU.

A.3 HIRS Measurement Data (Dig A)

The HIRS measurement data packet contains 64 HIRS 288-bit data elements acquired starting with 2nd 0.1 second cycle after the occurrence of the 6.4-second event. The data are stored back-to-back bitwise in the User Data area in the packet. The UTC (secondary header), OBT time (ancillary data) and Packet Error Code are present in this packet.

The CCSDS packet header information for these packets is:

Version #	=	000_2
Type	=	0
Secondary Header Flag	=	1 => presence of S/C UTC time tag
APID	=	26_{16}
Segment Flag	=	11_2
Packet Sequence Count	=	Sequential counter (Modulo 16384). Note That the first packet transmitted to TBCU may not start at zero.
Packet length	=	Number of data bytes in packet data field – 2325_{10}

The data field within the packet includes:

Bytes 0-7	Spacecraft UTC time code as defined in Section 2.3.1. The time code indicates the falling edge of the NIU internal 6.4 second sync Pulse **(TBC)**
Bytes 8-13	Ancillary Info OBT time field as defined in Section 2.3.1. The time code indicates the OBT time of the falling edge of the NIU internal 6.4 second sync pulse **(TBC)**
Bytes 14-2323	64 elements of HIRS data packed bitwise back-to-back in the order the HIRS instrument transmits the data over the DIG A data line. The first data sample is taken during the 2^{nd} 0.1-second period after the 6.4-second event. The data corresponds to the 0^{th} Earth Scan Element.
Bytes 1324-2325	Packet Error Control code

A.4 HIRS Housekeeping Data

The HIRS Housekeeping Data Packet Header information is:

Version #	=	011_2
Type	=	0
Secondary Header Flag	=	0=> No presence of S/C UTC time tag
APID	=	$7FD_{16}$
Segment Flag	=	11_2
Packet Sequence Count	=	Sequential counter (Modulo 16384). Note that the first packet transmitted to TBCU may not start at zero.
Packet length	=	Number of data bytes in packet data field –1. The value of the field is dependent upon the METOP ICU format selected. Valid lengths are: 63_{10} -Real-time Reduced Format 267_{10} –Real-time Format 3123_{10} –Real-time Test Format

Note that there is no UTC or Ancillary Info OBT time field or Packet Error Code for this packet type. The User Data field of this packet contains:

Byte Offset in User Data Field	Definition
0	ICU "Begin Identifier" = constant FF_{16}
1	ICU "Source" field = 74_{16} for HIRS
2	Bits 0-3 ICU "Type" field indicating Format 9_{16} - Real-time reduced A_{16} -Real-time 3_{16} - Real time Test Bits 4-7 N/A
3	8 bit counter (mod 256) that is common (global) to all formats.
4-5	16 bit integer indicating the number of 16 bit data words contained in the "User Data Field"
6-9	ICU time field of the data sample. The ICU time field is defined as follows: 3 bytes OBT coarse time in seconds 1 byte subseconds of time. Least significant bit $=2^{-8}$
10-15	Not Applicable
16-39	Spare
40	HIRS Dig B data defined as follows: Bit 0: Instrument Power (1=>ON) Bit 1: Electronics Power (1=>ON) Bit 2: Filter Motor Power (1=>ON) Bit 3: Scan Motor Power(1=>ON) Bit 4: Cooler Heater (1=>ON) Bit 5: Filter Housing Heater(1=>ON) Bit 6: Cooler Door Release(1=>ENABLE) Bit 7: Cooler Window Heater(1=>ON)
41	HIRS Dig B data defined as follows: Bit 0: GoTo NADIR Position (1=>YES) Bit 1: Calibration Sequence(1=>ENABLE) Bit 2: Cooler Door Closed(1=>NO) Bit 3 Cooler Door Fully Open(1=>NO) Bit 4: Filter Motor Power Level(1=>HIGH) Bit 5: Patch temperature Controller (1=>ON) Bits 6-7: Spare
42	Radiometer Temperature
43	Base Plate Temperature (Powered by +28 V analog)
44	Electronics Temperature
45	Patch Temperature
46	Filter Housing Controller Current
47	Scan Motor Temperature (Powered by 28 V analog Bus)
48	Filter Wheel Motor Temperature
49	+5 VDC Monitor
50	+10 VDC TLM/DC/DC Converter

51	+7.5 VDC TLM/DC/DC Converter
52	-7.5 VDC TLM/DC/DC Converter
53	+15 VDC Monitor
54	-15 VDC Monitor
55	Filter Wheel Motor Current
56	Scan Motor Current
57	Patch Controller Power
58-61	Spare
62-63	ICU “End Identifier” = $FFFF_{16}$
64-end	If present as indicated by the packet length field, contains information pertinent to the ICU and should treated as spare relative to the TBCU.

APPENDIX B – DETAILED FORMAT OF COMMAND AND CONTROL MESSAGES

The content of this appendix is based upon Draft 2.1, dated August 21, 1998 of the PLM EGSE ICD and the NOAA Instruments Interface Unit (NIU) Requirements Specification, Issue 1 Rev. A dated May 13, 1997.

B.1 General Message Characteristics

The syntax of the Command and Control Messages exchanged between the N-DAPB and TBCU is a subset of the complete syntax defined in the PLM Internal EGSE ICD. The full command syntax is not necessary because of the limited subset of commands exchanged between the systems. The applicable characteristics are:

a. The Data Filed contains ASCII characters.
b. Interpretation of the Data Field shall be case insensitive.
c. The Data Field does not contain a secondary header.
d. The Data Field does not contain the Ancillary Info OBT field.
e. The Data Field does not contain a Packet Error Control field.
f. The Data Field is variable length. The maximum length is 1024 characters.
g. The Data Field is comprised of a COMMAND portion and an optional FREE TEXT portion.
h. The COMMAND portion is terminated by an ASCII semicolon (;)
i. The COMMAND portion consists of a KEYWORD with optional arguments
j. The KEYWORD is separated from any arguments by a space character.
k. Each argument is an ASCII COMMAND ARGUMENT or TEXT STRING
l. An ASCII COMMAND ARGUMENT is an ASCII string, containing no space characters
m. A TEXT STRING is an ASCII string delineated by double quotation marks. A maximum of 80 characters may be between the quotes.
n. Command arguments are separated from each other with a comma (,)
o. The C&C message packet header data values are:

Version #	=	011_2
Type	=	1
Secondary Header Flag	=	0
APID	=	$7FA_{16}$ for C&C message requiring ACK/NACK
	=	$7FB_{16}$ for ACK/NACK message
Segmentation Flag	=	11_2
Source Sequence Count	=	Sequential Counter (Modulo 16384) unique to APID. Incremented by sender of message. May not be initialized to zero.
Packet length	=	Number of data bytes (characters) in Data Field –1. Number of data bytes In Data Field is a multiple of 2.

B.2 TRANSFER ONLINE Message

The TRANSFER ONLINE message consists of the following KEYWORD and single argument:

KEYWORD: TRANSFER
ARGUMENT: ONLINE

Example:

DATA FIELD BYTE	ASCII Character
0 - 1	Tr
2 - 3	An
4 - 5	Sf
6 - 7	ER
8 - 9	^o
10 -11	NL
12 - 13	IN
14 - 15	E;
16 - 17	FR
18 - 19	EE
20 - 21	^^
22 - 23	Te
24 - 25	xt

^ denotes the ASCII space character.

This message requires an ACK or NACK response

B.3 TRANSFER OFFLINE Message

The TRANSFER OFFLINE message consists of the following KEYWORD and single argument:

KEYWORD: TRANSFER
ARGUMENT: OFFLINE

Example:

DATA FIELD BYTE	ASCII Characters
0-1	Tr
2-3	An
4-5	sf
6-7	ER
8-9	^o
10-11	ff
12-13	LI
14-15	Ne
16-17	;^

^ denotes the ASCII space character.

This message requires an ACK or NACK response.

B.4 MESSAGE Message

The MESSAGE message consists of the KEYWORD followed by the text string of the informational message being exchanged.

DATA FIELD BYTE	ASCII Characters
0-1	ME
2-3	SS
4-5	Ag
6-7	E^
8-9	“H
10-11	I^
12-13	th
14-15	er
16-17	e”
18-19	;^
20-21	FR
22-23	EE
24-25	^T
26-27	EX
28-29	T^

^ denotes the ASCII space character.

This message requires an ACK or NACK response.

B.5 ACK Message

The ACK message is issued whenever a command requiring an ACK/NACK is received, has correct syntax and can be executed. The command consists of a KEYWORD ACK followed by the KEYWORD and arguments of the command it is acknowledging.

For instance, the ACK for the example of the TRANSFER ONLINE message defined in B.2 is:

DATA FIELD BYTE	ASCII Characters
0 - 1	AC
2 - 3	K^
4 - 5	Tr
6 - 7	An
8 - 9	sf
10 - 11	ER
12 - 13	^o
14 - 15	NL
16 - 17	In
18 - 19	e;

^ denotes the ASCII space character

No ACK /NACK is expected for this message.

B.6 NACK Message

The NACK message is issued whenever a command requiring an ACK/NACK is received, has incorrect syntax, is unknown to the receiver or cannot be executed. The command consists of a KEYWORD NACK followed by the KEYWORD and arguments of the command it is rejecting.

The following is an example of a NACK in response to a message with KEYWORD FOOBAR.

DATA FIELD BYTE	ASCII Characters
0 - 1	NA
2 - 3	CK
4 - 5	^F
6 - 7	OO
8 - 9	BA
10 - 11	R;

^ denotes the ASCII space character

No ACK/NACK is expected for this message.

B.7 ERROR Message

The Error Message is intended to provide a way for the TBCU to notify the N-DAPB of errors. Only the general format of the message has been documented. The details of the message will need to be negotiated with METOP after the error conditions have been identified.

The general format of the message is the KEYWORD ERROR followed by an ASCII field of TBD value. An ACK/NACK is expected for this message.

B.8 Command Echo Message

Each command issued to the AVHRR and HIRS instruments by the ground system is relayed to the TCBU in a packet that contains the ASCII mnemonic of the command. This message will be routed to the TBCU associated with the particular instrument

The message KEYWORD is MCMD_ECHO. The single argument is the command mnemonic.

The following is an example of the command echo message for the HIRS Scan Motor Off command:

DATA FIELD BYTE	ASCII Characters
0 - 1	MC
2 - 3	MD
4 - 5	_E
6 - 7	CH
8 - 9	O^
10 - 11	H2
12 - 13	SM
14-15	F;

^ Denotes the ASCII space character.

The Command echo Message requires and ACK/NACK response.

APPENDIX C. MIB-EBCU INTERFACE

C.1 General

Testing of instruments at ITT involves recording data on 9-track tape with the EBCU and then playing back this data through the EBCU for analysis. It is proposed to take advantage of this playback feature in the MIB-EBCU interface by transmitting data from the MIB to the EBCU in ITT data format

Data from the AVHRR and HIRS Instruments fall into three categories: analog housekeeping, digital instrument status-words, and science. Some of the analog housekeeping data is duplicated within the science data stream. Data from the METOP Spacecraft arrives in two types of CCSDS data packets. One packet contains one (1) scan line of science data. The other packet contains the housekeeping data: both analog and digital. Within the MIB, these packets must be decommutated and rewritten into the ITT formats described below. Analog data are sent to the EBCU as HP "C" 64 bit double precision words that represent voltages. Data are received from the spacecraft in counts and thus must be converted within MIB to voltages using algorithms supplied by ITT. If data are read out of the MIB faster than data are received, then the most recent data will be used.

During instrument testing at ITT, analog data characterizing the test conditions (vacuum chamber pressure, power supply voltages and currents, chamber and target temperatures, etc.) are recorded with the instrument data. These words are included in the output data format and are set to zero by the MIB software.

C.2 AVHRR

C.2.1 General Description

The AVHRR is a cross-track scanner that obtains images of the earth in five (5) wavelengths. The average data rate, including housekeeping, is 622.272 Kbps. Images of the Earth are obtained horizon to horizon using a continuously rotating mirror. Calibration of this instrument is obtained by taking ten (10) measurements of cold space at the beginning of each scan line and ten (10) measurements of its internal calibration target at the end of each scan line.

C.2.2 Science Data

Science data is sent to the spacecraft in 10-bit words. Five words, one (1) word for each of the 5 channels, is defined as one Earth view element. To each 10-bit word, the MIB adds 6 zero bits to make 16 bit words. Each CCSDS science packet contains one scan line of data of 2071 elements. To each packet, the MIB must add 40 elements of fill words to produce a scan line of 2111 elements. The ordering of the data within a scan line is presented in Table C.2-1.

Within each element or sample, data is read out of the instrument in the following sequence: Channel 1, channel 2, channel 3, channel 4, and Channel 5. However, the first channel read out of the MIB to the EBCU is Channel 5.

Table C.2-1. Scan Line Data Order

Sample Index	Samples/Line	Definition
0-9	10	Space View Radiance
10	1	Electronic-Cal
11-2058	2048	Scene Radiance
2059	1	ICT Temperature
2060	1	Patch Temperature
2061-2100	40	Fill Words (all zero)*
2101-2110	10	ICT Radiance

*These fill words are not in the CCSDS Packet but are added by the MIB

C.2.3 AVHRR Housekeeping Data

Analog T/M channels read by the EBCU is listed in Table C.2-2. Data entries in bold are from the instrument and external target and are required by the EBCU analysis software. Other channels are either test monitors or spare channels and should be set to zero in the MIB. The Earth Calibration Target will not be used during testing on METOP and this entry can be set to zero (**TBC**). The temperature of the Space Target is not transmitted over the LAN but will be provided directly to the MIB as an analog signal from the vacuum chamber.

Table C.2-2. Analog Sensor Channels

Channel Number	T/M Point	Description of T/M Point	Source
1	N/A	ITT Test Monitor	MIB
.			
5	N/A	ITT Test Monitor	MIB
6	RDTRT	Radiator Temperature	T/M
7	PPWR	Patch Power	T/M
8	PTL	Patch Temp. (Narrow Range)	T/M
9	PTE	Patch Temp. (Wide Range)	T/M
10	BLK1	ICT Temp. #1	T/M
11	BLK2	ICT Temp. #2	T/M
12	BLK3	ICT Temp. #3	T/M
13	BLK4	Internal Cal Target Temp. #4	T/M
14	MTRI	Scan Motor Current	T/M
15	ELEXI	Electronics Current	T/M
16	ESP	Earth Shield Position	T/M
17	ELEST	Electronics Temp.	T/M
18	BPT	Baseplate Temp.	T/M
19	CONVT	A/D Converter Temp.	T/M
20	MOTT	Scan Motor Housing Temp.	T/M
21	CLRT	Cooler Housing Temp.	T/M
22	DET4	Channel 4 Detector Bias Volt	T/M
23	DET5	Channel 5 Detector Bias Volt	T/M
24	BB4	ICT Channel 4 Radiometric Temp.	T/M
25	BB3B	ICT Channel 4 Radiometric Temp.	T/M
26	OFFV	Offset Voltage	T/M
27	BB5	ICT Channel 5 Radiometric Temp.	T/M
28	N/A	Spare	MIB
.			.
65	N/A	Line	MIB
66	ET1	Earth Cal Target Base Temp.	MIB
67	ET2	Earth Cal Target Base Temp.	MIB
68	ET3	Earth Cal Target Base Temp.	MIB
69	ET4	Earth Cal Target Base Temp.	MIB
70	ET5	Earth Cal Target Base Temp.	MIB
71	ET6	Earth Cal Target Base Temp.	MIB
72	ET7	Earth Cal Target Base Temp.	MIB
73	ET8	Earth Cal Target Base Temp.	MIB
74	N/A	Short	MIB
.		.	
88	N/A	ITT Test Monitor	MIB
89	ST1	Space Target Temperature	LAN (TBC)
90	ST2	Space Target Temperature	LAN (TBC)
91	ST3	Space Target Temperature	LAN (TBC)
92	N/A	Cooler door	MIB
.		.	
125	N/A	Spare	MIB

C.2.4 AVHRR Digital Telemetry Data

AVHRR digital telemetry data is received from the instrument as one 15-bit word and is sent to the EBCU as two 16-bit-words. However, the upper word and bit 15 in the lower word are not used. This word describes the configuration of the instrument and is used for command verification. Definition of each bit is described in Table C.2-3. NOTE: This is not CCSDS bit numbering scheme.

Table C.2-3 AVHRR Digital B Telemetry

BIT (0-LSB, 15-MSB)	Description	True ('1') (0.14V ± 0.25V)	False ('0') (+5.0V ± 0.7V)
0	Electronics Telemetry	ON	OFF
1	Scan Motor Telemetry	ON	OFF
2	Housekeeping Telemetry	Locked ON	Not Locked
3	Scan Motor Mode	High	Low
4	Cooler Heater	ON	OFF
5	Earth Shield	Deploy	Disable
6	Patch Control	ON	OFF
7	Voltage Calibrate	ON	OFF
8	Channel 1	Enable	Disable
9	Channel 2	Enable	Disable
10	Channel 3A/3B Select	3A	3B
11	Channel 3A	Enable	Disable
12	Channel 3B	Enable	Disable
13	Channel 4	Enable	Disable
14	Channel 5	Enable	Disable
15	Not Used	N/A	MIB

C.3 AVHRR MIB Data Output

C.3.1 General Description

Data from the AVHRR is sent from the MIB to the EBCU in standard ITT data format with a standard block length of 706 16-bit words. Thirty scan lines, 5 seconds of data, preceded by a header makes up a data group. Each scan line consists of 15 data blocks, so that a data group is 451 blocks. This format allows data that changes slowly over intervals of several seconds to be saved at 5 second intervals while the constantly changing video data is recorded continuously.

Each block in the below format has a specific purpose. Every block contains as the first word the type of block and its numerical sequence in its group. Bit 14 = 0 indicates a header block while bit 14 = 1 indicates video data. Bit 12 = 1 indicates that video data to follow.

The header block contains the date and time of the data, analog house keeping data and a digital word describing the instrument status and configuration. If radiometric data is being collected, the video blocks contain 30 scan lines of data. If video data is not being received, only the header block is sent to the EBCU.

C.3.2 AVHRR Header Block

The format of the Header Block is presented in Table C.3-1. The Date/Time code is stored in 8 bit ASCII in the following sequence: DAY sp MONTH sp HR:MIN:SEC sp YEAR sp sp.

Example: TUE_FEB_12_13:12:01_1988__.

Words 174-204, AVHRR Mirror Jitter, may not be available on the METOP Spacecraft (**TBC**). The sequence of analog channels is given in Table C.2-2. Word 205 in the header is set to 0 and Word 206, Digital Telemetry, is described in Table 3. Spare words and words needed only at instrument level testing at ITT and are set to 0.

Table C.3-1. AVHRR Header

	Bit Number															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
2-14	Date and Time															
15-65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66-174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175-204	AVHRR Mirror Jitter															
205-206	Digital T/M															
207-706	Analog channels 1-125															

C.3.3 AVHRR Video Data Blocks

The word definitions for the first 14 blocks of video data are given in Table C.3-2 and the word definitions for the 15th block is given in Table C.3-3. This sequence is repeated 30 times to give 30 scan lines of recorded data. Radiometric sensor data is received 10 bit words. Consequently the 6 MSB are set to 0. Note that the 15th video block is not completely filled but contains 686 words rather than 706. The unused words are filled with zeros.

Table C.3-2. AVHRR Video Block 1-Block 14

	Bit Number															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	0	1	0	0	0	BLOCK - NUMBER								
2	ZEROS							Channel 5								
3	ZEROS							Channel 1								
4	ZEROS							Channel 2								
5	ZEROS							Channel 3								
6	ZEROS							Channel 4								
.	.	.	.	.	.	.										
.	.	.	.	.	.	.										
706	ZEROS							Channel 4								

Table C.3-3 AVHRR VIDEO BLOCK 15

	Bit Number															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	0	1	0	0	0	BLOCK - NUMBER								
2	ZEROS							Channel 5								
3	ZEROS							Channel 1								
4	ZEROS							Channel 2								
5	ZEROS							Channel 3								
6	ZEROS							Channel 4								
.																
.																
686	ZEROS							Channel 4								
687-706	ZEROS							ZEROS								

C.4 HIRS

C.4.1 General Description

The HIRS is a step-and-stare cross-track scanning radiometer. At each of 56 scan positions it measures the radiance from the Earth's atmosphere at 20 wavelengths. Wavelength discrimination is obtained by means of a filter wheel. During retrace, which is a time corresponding to 8 earth scan positions, the data format is changed to provide for measurement of the internal electronic calibration and to sample all of the housekeeping telemetry data. Calibration of the instrument is provided at 256-second intervals by observing a warm target mounted on the base of the instrument and a view of space.

With every filter-wheel revolution, a block of data is generated. This block, called an element, is 288 bits long. Each CCSDS packet contains one (1) scan line of data consisting of 56 earth scene views and 8 retrace elements containing other data. Each element is numbered 0 through 63 and this 6-bit binary number is included in each element at bit location 20-25. It should be noted that element 0, the first scan position, occurs at encoder position 1. The average packetized data rate is 2.905 Kbps.

C.4.2 HIRS Science Data

Science data is sent to the spacecraft from HIRS as consecutive 13-bit words. The MSB of this word is a sign bit with "1" being plus and "0" being negative. Identical to AVHRR, one scan line of science data makes up one CCSDS Science Packet and a second CCSDS data packet contains both the Analog and Digital B housekeeping data.

The data format of the HIRS Instrument is more complicated than that of AVHRR and is given in Table C.4-1.

Table C.4-1. HIRS Digital A Data Output Format

Element 0-55	
Bit 1-8	Encoder Position
Bit 9-13	Electronic Calibration Level
Bit 14-19	Channel 1 Period Monitor
Bit 20-25	Element Number
Bit 26	Filter Sync Designator
Bit 27-286	Radiant Signal Output (20 Channels x 13 Bits)
Bit 287	Valid Data Bit (1=Data Valid, 0=Mirror Slewing)
Bit 288	Parity Check
Element 56	
Bit 1-26	Same Above
Bit 27-286	Positive Electronic Cal (20 Channels x 13 Bits)
Bit 287, 288	Same as Above
Element 57	
Bit 1-26	Same as Above
Bit 27-286	Negative Electronic Cal (20 Channels x 13 Bits)
Bit 287,288	Same as Above
Element 58	
Bit 1-26	Same as Above
Bit 27-91	Internal Warm Target (13 bits x 5 Samples)
Bit 92-156	Internal Warm Target (13 bits x 5 Samples)
Bit 157-221	Internal Warm Target (13 bits x 5 Samples)
Bit 222-286	Internal Warm Target (13 bits x 5 Samples)
Bit 287,288	Same as Above
Element 59	
Bit 1-26	Same as Above
Bit 27-91	Internal Cold Target (13 Bits x 5 Samples)
Bit 92-156	Ground
Bit 157-221	Internal Warm Target (13 bits x 5 Samples)
Bit 222-286	Tertiary Telescope Temp. (13 bits x 5 Samples)
Bit 287,288	Same as Above
Element 60	
Bit 1-26	Same as Above
Bit 27-91	Filter Housing Temp (13 bits x 5 Samples)
Bit 92-156	Filter Housing Temp (13 bits x 5 Samples)
Bit 157-221	Filter Housing Temp (13 bits x 5 Samples)
Bit 222-286	Filter Housing Temp (13 bits x 5 Samples)
Bit 287,288	Same as Above
Element 61	
Bit 1-26	Same as Above
Bit 27-91	Patch Temp. Expanded (13 bits x 5 Samples)
Bit 92-156	First Stage Temp (13 bits x 5 Samples)
Bit 157-221	Filter Housing Control Power/Temp (13 bits x 5 Samples)
Bit 222-286	Electronic DAC Calibration (13 bit x 5 Samples)
Bit 287, 288	Same as Above

Table C.4-1. HIRS Digital A Data Output Format (continued)

Element 62	
Bit 1-26	Same as Above
Bit 27-39	Scan Mirror Temp.
Bit 40-52	Primary Telescope Temp.
Bit 53-65	Secondary Telescope Temp.
Bit 66-78	Baseplate Temp.
Bit 79-91	Electronics Temp.
Bit 92-104	Patch Temp. (Full Range)
Bit 105-117	Scan Motor Temp.
Bit 118-130	Filter Motor Temp.
Bit 131-143	Radiant Cooler Housing Temp.
Bit 144-156	Patch Control Power
Bit 157-169	Scan Motor Current
Bit 170-182	Filter Motor Current
Bit 183-195	+15 V
Bit 196-208	-15 V
Bit 209-221	+ 7.5 V
Bit 222-234	-7.5 V
Bit 235-247	+10 V
Bit 248-260	+5 V
Bit 261-273	Analog Ground
Bit 274-286	Analog Ground
Bit 287, 288	Same as Above
Element 63	
Bit 1-26	Same as Above
Bit 27-39	Line Count
Bit 40	Fill Zero
Bit 41-44	Instrument S/N
Bit 45	Instrument ON/OFF
Bit 46	Scan Motor ON/OFF
Bit 47	Filter Wheel Motor ON/OFF
Bit 48	Electronics ON/OFF
Bit 49	Cooler Heater ON/OFF
Bit 50	Internal Warm Target Position
Bit 51	Internal Cold Target Position
Bit 52	Space Position
Bit 53-57	Fill Zeros
Bit 58	Nadir Position
Bit 59	Calibration Enable/Disable
Bit 60	Cover Release Enable/Disable
Bit 61	Cooler Cover Open
Bit 62	Cooler Cover Closed
Bit 63	Filter Housing Heater ON/OFF
Bit 64	Patch Temp. Control ON/OFF
Bit 65	Filter Motor Power HIGH
Bit 66-78	Binary Code (1111100100011) +3875 base10
Bit 79-286	Fixed Word Pattern (+1443, -1522, -1882, -1631, -1141, +1125, +3655, -2886, -3044, -3764, -3262, -2283, -2251, +3214, +1676, +1992)
Bit 287, 288	Same as Above

C.4.3 HIRS Housekeeping Data

Housekeeping data is transmitted in a separate data packet than the science data. This data consists of analog temperatures, voltages, and currents and digital instrument configuration information. Both analog and the digital data are transmitted in the same CCSDS packet.

Table C.4-2 defines the order of the analog data sent to the EBCU. Entries in bold are either from the instrument or external targets and must be sent to the EBCU. Other channels are test chamber monitors or spare channels and should be set to zero. The Earth Calibration Target and Space Targets will not be used during testing on METOP. These entries can be set manually or by software to a nominal value (TBC). The temperature of the Cooler Target will be transmitted over the LAN as a Facilities Message (TBD).

C.4.4 HIRS Digital B Telemetry Data

HIRS Digital B telemetry data is one 16-bit-word. This word describes the configuration of the instrument and is used for command verification. Bits 15 and 16 of this word are not used and are set to zero in the MIB. Definition of each bit of this word is given in Table C.4-3.

Table C.4-2 HIRS Analog Sensor Channels

Analog Channel	T/M Point	Description of T/M Point	Source
1	N/A	Test Monitor at ITT	MIB
.			
5	N/A	Test Monitor at ITT	MIB
6	RDTRT	Radiator Temp.	T/M
7	BPT	Baseplate Temp,	T/M
8	ELEXT	Electronics Temp.	T/M
9	PCHT	Patch Temp.	T/M
10	FHC	Filter Wheel Housing Temp.	T/M
11	SMT	Scan Motor Temp.	T/M
12	FMT	Filter Wheel Housing Temp.	T/M
13	SPARE	Spare	MIB
14	+5V	+5V Monitor	T/M
15	+10V	+10V Monitor	T/M
16	+7.5V	+7.5V Monitor	T/M
17	-7.5V	-7.5V Monitor	T/M
18	+15V	+15V Monitor	T/M
19	-15V	-15V Monitor	T/M
20	FMC	Filter Wheel Motor Current	T/M
21	SMC	Scan Motor Current	T/M
22	PCP	Patch Power	T/M
23	N/A	Spare	MIB
.			
55	N/A	Short	MIB
56	ET1	Earth Cal Target Temp.	MIB
57	ET2	Earth Cal Target Temp.	MIB
58	ET3	Earth Cal Target Temp.	MIB
59	ET4	Earth Cal Target Temp.	MIB
60	ET5	Earth Cal Target Temp.	MIB
61	ET6	Earth Cal Target Temp.	MIB
62	ET7	Earth Cal Target Temp.	MIB
63	ET8	Earth Cal Target Temp.	MIB
64	N/A	Spare	MIB
65	N/A	Spare	MIB
66	ST1	Space Target Temperature	MIB
67	ST2	Space Target Temperature	MIB
68	N/A	Radiant Cooler	LAN (TBC)
		.	.
95	N/A	Spare	MIB

Table C.4-3 HIRS Digital B Telemetry

BIT(*) (0-LSB, 16-MSB)	Description	True ('1') (0.14V ± 0.25V)	False ('0') (+5.0V ± 0.7V)
0	Instrument Power	ON	OFF
1	Electronics Power	ON	OFF
2	Filter Motor Power	ON	OFF
3	Scan Motor Power	ON	OFF
4	Cooler Heater	ON	OFF
5	Filter Housing Heater	ON	OFF
6	Cooler Door Release	Enable	Disable
7	Cooler Window Heater	OFF	ON
8	Go to Nadir Position	YES	NO
9	Calibration Sequence	Enable	Disable
10	Cooler Door Closed	NO	YES
11	Cooler Door Fully Open	NO	YES
12	Filter Motor Power Level	High	Normal
13	Patch Temp. Controller	ON	OFF
14	Not Used	N/A	MIB
15	Not Used	N/A	MIB

(*) NOTE: Bit number scheme is not per CCSDS convention.

C.5 HIRS MIB Data Output

C.5.1 General Description

The MIB receives HIRS data in CCSDS data packets from the N-DAPB. After removing the CCSDS packet headers, this data is placed in a file in standard magnetic tape format along with added data such as date and time. This file is then transferred to the EBCU in standard blocks of 24 16-bit words. A data group consists of one scan line of science data preceded by a header and 20 blocks of housekeeping data. This is the amount of data collected over a 6.4-second period.

Each block in the below format has a specific purpose. Every block contains as the first word the type of block and its numerical sequence in its group. Bits 15 and 14 define the type of block: 00 designates the header block, 10 designates housekeeping data block, and 11 designates a science data block.

C.5.2 HIRS Header Block

The format of the Header Block is presented in Table C.5-1.

The Date/Time code is stored in 8 bit ASCII in the following sequence: DAY sp MONTH sp HR: MIN: SEC sp YEAR sp sp. Example: TUE_FEB_12_13:12:01_1988__.

The LSB of Word 2 is a data valid bit, which specifies if the data to follow has been properly synchronized (**TBC).**

C.5.3 HIRS Data Blocks

The format of the first data block following the header block is given in Table C.5-2. Words 2-21 contain the first 5 analog data points, which are set to zero in the MIB. Word 22 is defined as 0 and words 23 and 24 are the digital telemetry data. Two words are reserved for digital telemetry but the instrument generates only one word.

Block 2, Table C.5-3, is reserved for future use and is currently all zeros except for the first word. Following Block 2 are 18 blocks containing the 90 remaining analog data points: see Table C.5-4. Channel 6 is the first analog data in Words 2-5 of Block 3 and Channel 90 appears in Words 18-21 of Block 20.

The last 64 blocks in a data group contain the science data. The format for these blocks is given in Table C.5.5. It should be recalled that the HIRS science data is 13-bit words including a sign bit. Therefore, 3 data bits of **TBD** must be added to make a 16-bit word.

Table C.5-1. HIRS Group Header

	Bit Number															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	Number of Blocks in this Scan Line							Block Number						
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**S**
3-15	<Date and Time>															
16-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.5-2 HIRS Block 1

	Bit Number															
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	Blocks in this Line							Block Number						
2-22	<ZEROS>															
23-24	<Digital B Telemetry>															

Table C.5-3 HIRS Block 2

	Bit Number															
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	Blocks in this Line							Block Number						
2-22	<ZEROS>															
23-24	<Digital B Telemetry>															

Table C.5-4 HIRS Blocks 3-20

	Bit Number															
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	Blocks in this Scan Line							Block Number						
2-21 24	<5 analog channels/block starting with channel 6> <ZEROS>															

Table C.5-5. HIRS Video Blocks 24-87

Word	Bit Number															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	Blocks in Line							Block Number						
2-23	TBD			<Science Data>												
24	TBD			DATA		ZEROS										

APPENDIX D: TBC / TBD LIST

PARAGRAPH	ITEM
Table 2.3-2 Port Number Identification	Port Numbers are TBD
A.1 AVHRR Measurement Data (Dig A)	The 10 bit fields are ordered so that the most significant bit (AVHRR data line #1) is transmitted first. Note that the LAST 2 bits of byte 12957 are indeterminate and are present to fill out the last byte. (TBC)
A.1 AVHRR Measurement Data (Dig A)	Bytes 0-7 Spacecraft UTC time code as defined in Section 2.3.1. The time code indicates the falling edge of the NIU internal 6.4 second sync Pulse (TBC)
A.1 AVHRR Measurement Data (Dig A)	Bytes 8-13 Ancillary Info OBT time field as defined in Section 2.3.1. The time code indicates the OBT time of the falling edge of the NIU internal 6.4 second sync pulse (TBC)
B.7 ERROR Message	The general format of the message is the KEYWORD ERROR followed by an ASCII field of TBD value.
Table C.2-2. Analog Sensor Channels	Space Target Temperatures (LAN (TBC))
C.2.3 AVHRR Housekeeping Data	The Earth Calibration Target will not be used during testing on METOP and this entry can be set to zero (TBC).
C.3.2 AVHRR Header Block	Words 174-204, AVHRR Mirror Jitter, may not be available on the METOP Spacecraft (TBC).
C.4.3 HIRS Housekeeping Data	The Earth Calibration Target and Space Targets will not be used during testing on METOP. These can be set manually or by software to a nominal value (TBC).
C.4.3 HIRS Housekeeping Data	The temperature of the Cooler Target will be transmitted over the LAN as a Facilities Message (TBC).
Table C.4-2 HIRS Analog Sensor Channels	Radiant Cooler Temperature is LAN (TBC)
Table C.4-3 HIRS Digital B Data Output Format	Earth Cal target temperatures are TBD. Space Target Temperatures are TBD.
C.5.2 HIRS Header Block	Bytes 14-12957 The LSB of Word 2 is a data valid bit, which specifies if the data to follow has been properly synchronized (TBC).
C.5.3 HIRS Data Blocks	Therefore, 3 data bits of TBD must be added to make a 16-bit word.
Table C.5-5. HIRS Video Blocks 24-87	Bits 15, 14, and 13 for words 2 – 24 are TBD.

APPENDIX E: ACRONYMS

ACRONYM	DEFINITION
ACK	Acknowledge
APID	Application Process Identifier
AVHRR	Advanced Very High Resolution Radiometer
C&C	Command and Control
CCR	Configuration Change Request
CCSDS	Consultative Committee for Space Data Systems
DFE	Data Front End
EGSE	Electrical Ground Support Equipment
ESA	European Space Agency
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
GSFC	Goddard Space Flight Center
HIRS	High Resolution Infrared Radiation Sounder
ICD	Interface Control Document
IEEE	International Electronics,
IP	Internet Protocol
ITT	International Telephone and Telegraph (Aerospace/Communications Division)
METOP	
MIB	METOP Interface Box
MOD	Modification
N-DAPB	NOAA – Data Acquisition and Processing Block
NACK	Not Acknowledged
NASA	National Aeronautics and Space Agency
NOAA	National Oceanic and Atmospheric Administration
OBT	On Board Time
PLM	Payload Module
RNIMS	Read N-DAPB Initiated Messages Socket
SCOE	Special Checkout Equipment (METOP)
SUMS	Send Unsolicited Message Socket
TBC	To Be Checked
TBCU	Transportable Bench Check Unit
TBD	To Be Determined
TCP	
TM	Telemetry
UTC	Universal Time (also same as the SC Time)